Descurainia torulosa Rollins (Wind River tansymustard): A Technical Conservation Assessment

Prepared for the USDA Forest Service,
Rocky Mountain Region,
Species Conservation Project

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Author's Biography

Bonnie Heidel graduated with a Bachelor of Arts degree from Carleton College in Northfield, MN, majoring in Biology, with honors awarded for her senior thesis. She graduated with a Masters degree in Botany from Washington State University in Pullman, WA, working on the rare plants of northern Idaho. She worked on Threatened and Endangered species for the U.S. Fish & Wildlife Service regional office in Portland, OR, on plant species status compilation in the Midwest Regional Office of The Nature Conservancy in Minneapolis, MN, on statewide sensitive species survey and related research in natural heritage program positions in Bismarck, ND and in Helena, MT. She is Botanist of the Wyoming Natural Diversity Database, a research program of the University of Wyoming, conducting botanical surveys and research throughout the state, and providing technical information services.

Cover Photo Credit

Descurainia torulosa (Wind River tansymustard). Photograph by Hollis Marriott.

List of Errata

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF *DESCURAINIA TORULOSA*

Status

Descurainia torulosa (Wind River tansymustard) is endemic to the southern Absaroka Mountains and the Rock Springs Uplift in western Wyoming. It is designated a sensitive species by the Rocky Mountain Region (Region 2) of the USDA Forest Service, the Intermountain Region (Region 4) of the USDA Forest Service, and the Bureau of Land Management (BLM) in Wyoming. The NatureServe Global rank for this species is critically imperiled (G1). It is ranked critically imperiled (S1) in Wyoming by the Wyoming Natural Diversity Database. Half of all known occurrences (6 of 12) are in Region 2, on the Shoshone National Forest.

Primary Threats

Descurainia torulosa occupies rocky cliff habitat, often in remote settings. It is not known to be affected by most management actions, but any destabilizing activities that bury or shift the strata or expose the microhabitat where it occurs could threaten populations. This potentially includes road construction, telecommunication facilities construction, and (on BLM lands) seismic activity and other developments associated with oil and gas development. *Descurainia torulosa* is also vulnerable to burial and destabilization of its habitat from rock slides. Grazing and recreation activities are present in areas adjacent to occupied *Descurainia torulosa* habitat but are not known to be direct threats with the exception that increased recreational use has been noted as a potential impact at one site outside of Region 2 on BLM lands. Some populations are potentially affected by projects and actions that introduce or expand the distribution of exotic plant species in the landscape.

Primary Conservation Elements, Management Implications and Considerations

Descurainia torulosa is an endemic that has narrow ecological amplitude, and it is a short-lived species with low population numbers. Maintaining the population viability of *D. torulosa* involves maintaining cliff habitat. The forces of erosion and drought cycles may be recurring threats to population persistence under natural conditions regardless of land status. Half of all known populations on the Shoshone National Forest (3 of 6) are on multiple use lands, and the other half are on the North Absaroka and Washakie wilderness areas. Outside of Region 2, three populations occur nearby on Bridger-Teton National Forest (Region 4) on multiple use lands. There are also three populations that occur on BLM-administered lands. All three BLM sites are in areas designated as Areas of Critical Environmental Concern (ACEC), and conservation of *D. torulosa* is identified as a management objective in two of them. The wilderness designations on Shoshone National Forest and the ACEC designations on BLM lands constrain developments and contribute to protection of the species' viability.

Descurainia torulosa is accepted as a valid taxon, but this assessment is preliminary until there is taxonomic research to determine whether this taxon is most appropriately recognized at the species or variety level. In a 1998 DNA sequencing study of *D. torulosa* by Jerry Bricker and Gregory Brown, University of Wyoming, it was suggested that *D. torulosa* is similar genetically to *D. incana*, and it might be more appropriately recognized as a variety of the latter (Bricker and Brown 1998). The researchers concluded that any taxonomic revisions involving *D. torulosa* will require better clarification of species concepts and relationships within the *Descurainia* genus (Bricker et al. 2000).

The taxonomic status of *Descurainia torulosa* is further complicated by questions whether northern and southern subpopulations are taxonomically distinct. *Descurainia torulosa* has an unusual distribution broken into northern and southern segments that have contrasting habitats, and the segments are separated by about 180 miles (290 km). Bricker et al. (2000) did not resolve whether northern and southern populations represent the same taxon, though they are in the same clade in a preliminary cladistic analysis of morphological characteristics. For purposes of this assessment, *D. torulosa* is addressed under current taxonomic treatments and the premise that it is distinct at some level. The unusual habitat requirements and distribution patterns are part of its evolutionary puzzle and conservation assessment challenge.

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EDITOR: Beth Burkhart, USDA Forest Service, Rocky Mountain Region

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INTRODUCTION

This assessment is one of many being produced to support the Species Conservation Project of the Rocky Mountain Region, USDA Forest Service (USFS) – Region 2. *Descurainia torulosa* is the focus of an assessment because it is a sensitive species in Region 2 (USDA Forest Service 2003). Within the National Forest System, a sensitive species is a plant or animal whose population viability is identified as a concern by a regional forester because of significant current or predicted downward trends in abundance or habitat capability that would reduce its distribution (USDA Forest Service 1995). A sensitive species may require special management, so knowledge of its biology and ecology is critical.

This assessment addresses the biology of *Descurainia torulosa* throughout its range in Region 2. The broad nature of the assessment leads to some constraints on the specificity of information for particular locales. This introduction defines the goal of the assessment, outlines its scope, and describes the process used in its production.

Goal

Species conservation assessments produced as part of the Species Conservation Project are designed to provide forest managers, research biologists, and the public with a thorough discussion of the biology, ecology, conservation status, and management of certain species based on available scientific knowledge. The assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. The assessment does not seek to develop specific management recommendations but provides the ecological background upon which management must be based. While the assessment does not provide management recommendations, it does present the available information on the consequences of changes in the environment that result from management. It provides a reference to promote species conservation on Forest Service lands (Blankenship et al. 2001).

Scope

The *Descurainia torulosa* assessment examines the biology, ecology, conservation status, and management of this species throughout its range with specific reference to the geographic and ecological characteristics of the USFS Region 2 under current environmental conditions. The species is concentrated on lands administered as part of Region 2 in the Shoshone National Forest, Wyoming. However, the most detailed information on the species is from outside of Region 2. *Descurainia torulosa* occurs elsewhere in the Absaroka Range on Bridger-Teton National Forest (Region 4). It also occurs on one BLM site in the Absaroka Range near Shoshone National Forest. The Absaroka Range populations, including Region 2 populations, collectively represent the northern populations. *Descurainia torulosa* also occurs in Wyoming on BLM lands in the Rock Springs Uplift, outside of Region 2, representing the southern populations. It is imperative to address all 12 known populations of *D. torulosa* and the taxonomic questions associated with them to understand the species' status in Region 2.

In producing the assessment, refereed literature, non-refereed literature including status reports and interim research reports, herbarium specimen labels, and communications with researchers were incorporated. Existing distribution data and GIS environmental data layers were also used to assess potential distribution and adequacy of existing survey information. A summary of the potential distribution model results by Fertig and Thurston (2003 (http://uwadmnweb.uwyo.edu/WYNDD/Reports/pdf_fertig/FinalReport_03BLMmodeling.pdf)) is incorporated in the body of this report. This compiled information provides the most complete available documentation on the status of *Descurainia torulosa*, a species that was first described 20 years ago (Rollins 1983).

Treatment of Uncertainty

Science represents a rigorous, synthetic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions of the world are always incomplete and our observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is difficult to conduct critical experiments in the ecological sciences, and often observations, inference, good thinking, and models must be relied on to guide the understanding of ecological relations.

Confronting uncertainty, then, is not prescriptive. The data and analyses presented in this document are based on published and unpublished literature and systematic surveys in a portion of the range of *Descurainia torulosa* in Wyoming. The technical

information resources are not exhaustive but provide an initial framework for interpreting distribution and biology. In this assessment, the strength of evidence for particular ideas is noted, and alternative explanations are described when appropriate. While well-executed experiments represent a strong approach to developing knowledge, alternative approaches such as modeling, critical assessment of observations, and inference are accepted as sound approaches to understanding features of biology and are used in synthesis for this assessment.

Publication on the World Wide Web

To facilitate use of species assessments in the Species Conservation Project, they are being published on the Region 2 World Wide Web site. Placing the documents on the web makes them available to agency biologists and the public more rapidly than publishing them as reports. More importantly, it facilitates revision of the assessments, which will be accomplished based on guidelines established by Region 2.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to release on the web. This assessment of *Descurainia torulosa* was reviewed through a process administered by the Center for Plant Conservation, employing at least two recognized experts on this or related taxa. Peer review was designed to improve the quality of communication and to increase the rigor of the assessment.

MANAGEMENT STATUS

This section discusses the special management status, existing regulatory mechanisms, and biological characteristics of *Descurainia torulosa* in Region 2.

Management Status

In 1985, *Descurainia torulosa* was listed as a Category 2 species by the U.S. Fish and Wildlife Service (USFWS) under the Endangered Species Act (Federal Register of 27 Sept. 1985). In 1990, it was elevated from Category 2 to Category 1 as a candidate for Federal listing as Threatened (USDI Fish and Wildlife Service 1990). Category 1 candidates are those taxa for which there is sufficient information on biological vulnerability and threats to support proposals to list, whereas Category 2 status indicates that additional information is needed.

In 1991, *Descurainia torulosa* was recommended for return to Category 2 status because insufficient information was available to make a decision on listing (Marriott 1991). In particular, the taxonomic status of the plant was not clear. In addition, systematic surveys up to that time had been inadequate in the southern portions of the species' range. In 1993, it was changed from Category 1 to Category 2 status (Federal Register of 30 September 1993). When the Category 2 designation was eliminated in 1996, *D. torulosa* ceased to have any status under the Endangered Species Act.

Descurainia torulosa is designated as sensitive by the USFS Region 2 (USDA Forest Service 2003) and Region 4 (USDA Forest Service 1991). It is also designated as sensitive by the Wyoming BLM (USDI Bureau of Land Management 2001). It is only known from federal lands, and it is considered sensitive on all of the federal lands where it occurs.

Descurainia torulosa is currently ranked G1, indicating that it is critically imperiled throughout its global range (NatureServe 2003). It is ranked S1 in Wyoming, indicating that it is critically imperiled throughout the state, which circumscribes its entire range (Keinath et al. 2003). There is no legislation or management policy in the state that accompanies this ranking status.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

In Region 2, *Descurainia torulosa* occurs mainly on National Forest System land of the Shoshone National Forest. There is also one population nearby on BLM land administered by the Cody Field Office.

Throughout the range of *Descurainia torulosa*, six of the twelve occurrences are found on lands having special designation that preclude or constrain construction projects. In Region 2, it occurs on Shoshone National Forest where there are three occurrences in the North Absaroka and Washakie wilderness areas. Near the Shoshone National Forest to the east, the Carter Mountain population lies within BLM Carter Mountain ACEC. In addition, the two southern populations occur in two ACECs that were created for the primary purpose of conserving *D. torulosa* and other botanical resources. These areas were established in the Green River Resource Management Plan (USDI Bureau of Land Management 1996) and are administered by the Rock Springs Field Office. These designations limit or constrain human activities and developments that

potentially impact the species. All other occurrences are on federal lands managed for multiple-use.

There are no other laws, regulations, management plans, or conservation plans that address *Descurainia torulosa* apart from its sensitive species status, which confers some protection from human-caused activities and developments. As a sensitive species, *D. torulosa* populations on Shoshone National Forest are considered when evaluating project proposals and management plans. Potential impacts to populations have not been identified in the review process to date (Houston personal communication 2002). Even though there are no immediate threats in the Rocky Mountain Region, the relative remoteness and inaccessibility of locations where *D. torulosa* occurs may not confer long-term protection because the species is vulnerable to natural disturbance associated with rockslides and possibly to drought cycles.

Biology and Ecology

Classification and description

Descurainia torulosa Rollins (Wind River tansymustard) is a biennial, short-lived perennial, or occasionally an annual herb (Marriott 1991, 1992, Rollins 1983, 1993). It grows up to 15 cm tall with branched or unbranched multiple stems (**Figure 1**, **Figure 2**) that are procumbent or decumbent and arise from a taproot and unbranched crown. It has finely divided, stellate hairs that give the stem and leaves a gray-green appearance, and it does not have glands. The basal leaves are once- or twice-pinnately divided, 2 to 3 cm long, with primary lobes that are simple or with one or two subsidiary lobes. The cauline leaves are few and are similar to the basal leaves. The basal leaves are densely clustered, at least when young (Scott 1995), and may be lost with age (Marriott 1992). The flowers are yellow and drying whitish, with four petals, and 1.5 mm long. The fruits are 8 to 15 mm long, torulose, tapered below and toward the tip, arcuate to nearly straight, terete, usually gray-green with stellate hairs (sometimes glabrous) and borne on erect stalks usually less than 3 mm (3.5 mm) long. The fruits are closely appressed to the inflorescence axis at least above. The seeds are in a single row, narrowly oblong, plump, ca. 1.3 mm long, wingless, ca. 0.5 mm in diameter, and dark brown (Rollins 1983, USDA Forest Service 1989, Marriott 1991, 1992, Rollins 1993, Fertig et al. 1994, Scott 1995, Fertig 2000, Dorn 2001). Mature fruits are required for identification.

Detling (1939) addressed the reliability of morphological characters in determinations in *Descurainia*. He found growth habit, pubescence (excluding glandulosity), general shape of siliques (linear vs. broader), orientation of pedicels and siliques, size of flowers, and flower color to be most useful. Of these characters, growth habit, pubescence, and pedicel/fruit orientation are considered to be most relevant in considering the taxonomic status of *D. torulosa* by Rollins (1983, 1993) and Dorn (2001).

Rollins (1983) originally placed diagnostic significance on a suite of fruit characteristics that have been used to separate *Descurainia torulosa* from related taxa: siliques torulose, appressed but flaring outward, on extremely short pedicels (equal or less than 2.5 mm). Dorn (1992, 2001) added fruit pubescence (sometimes sparsely so) as a primary character to distinguish *D. torulosa* from *D. incana*. However, the Sweetwater County population at Pine Butte has glabrous fruits (Bricker et al. 2000). At least one of the Absaroka specimens had pedicels greater than 3 mm, on the North Fork drainage (Bricker et al. 2000). Plants determined as *D. torulosa* have siliques ranging from appressed to weakly divergent. The degree to which siliques are torulose ranges from mild to obvious, but it is not qualitatively different from torulose fruits seen in a wide range of *D. incana* specimens (Bricker et al. 2000).

Rollins (1983, 1993) also distinguished *Descurainia torulosa* by its growth form. He stated (1993) "This species is the only putative perennial *Descurainia* in North America. There are several such species in South America. The flowering stems arise laterally from beneath the crown of radial leaves and are procumbent, providing a distinctive habit of growth." He further distinguished it as "perennial or apparently so; siliques splitting from the apex downward; stems prostrate and with small cauline leaves or none."

However, the life history and growth form are not consistent within and between populations. Some plants from the two Sweetwater County populations appear to be annuals (Marriott 1992, Bricker et al. 2000), though vegetative rosettes are present as well. Flowering/fruiting individuals from northern populations that appeared to be in the first season of growth were also noted. In particular, the Carter Mountain specimen appears to be annual (very slender taproot, no crown). This population was not relocated in 1989 (Dorn 1989). Instead, plants of *Descurainia incana* were located, but the precise location of the original collection was

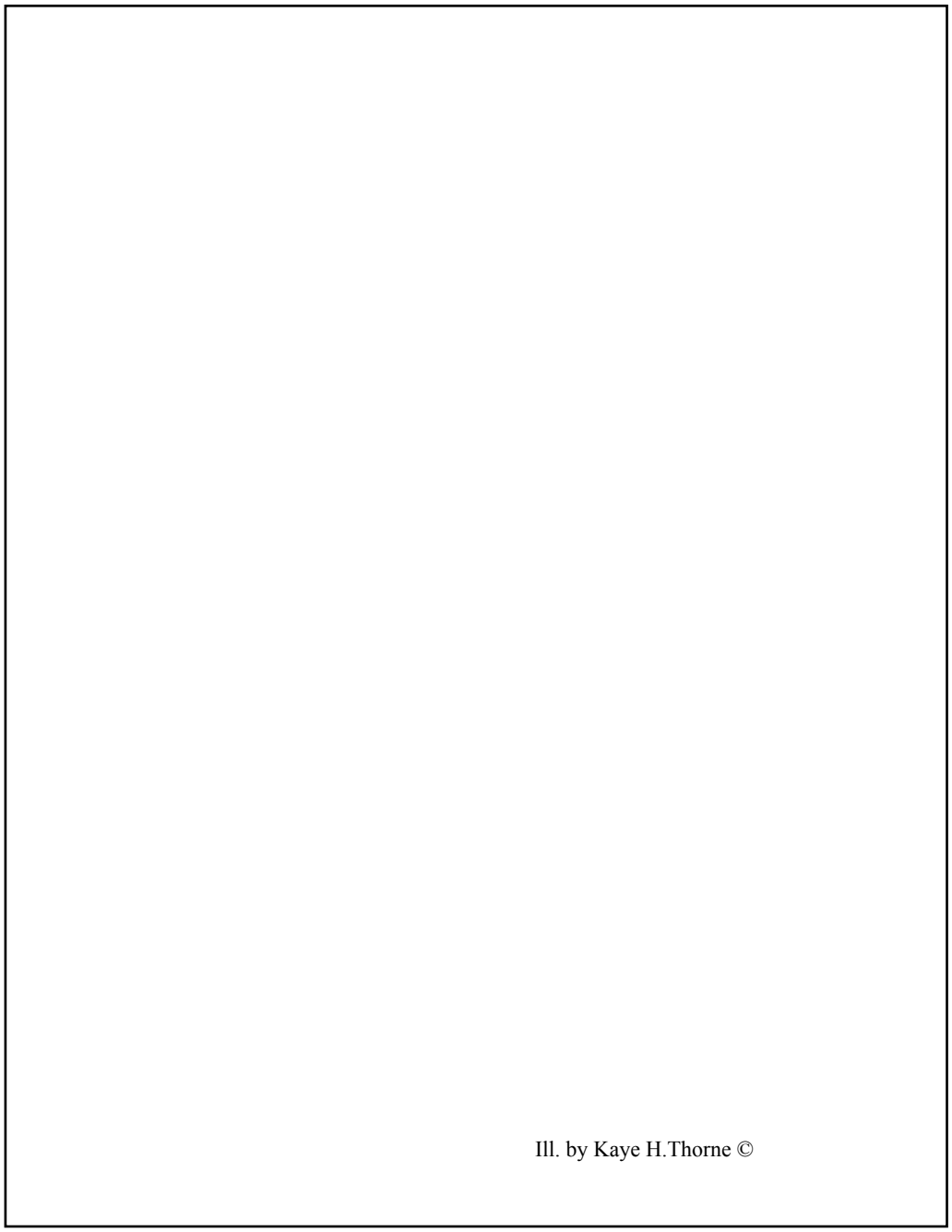

Figure 1. *Descurainia torulosa* illustration, by Kaye H. Thorne (from Fertig et al. 1994).

not given to be sure that the original site was revisited. Growth form in particular may be more a function of plant vigor than a genetic trait. In a systematic morphological analysis of all specimens, Bricker et al. (2000) concluded that the long-lived perennial habit does not appear to exist within *D. torulosa*. They also noted that small, flowering individuals have growth forms that range from erect to decumbent, but they are definitely not procumbent. Larger and presumably older flowering specimens tend to be more decumbent, but not procumbent. Thus, they also concluded that "…there is no unequivocal character, nor suite of characters, that can be used to distinguish *D. torulosa* with absolute reliance" (Bricker et al. 2000).

Figure 2. *Descurainia torulosa* photo, by A. Flinck.

The differentiating characteristics are reduced to generalities. The varieties of *Descurainia incana* (syn. *D. richardsonii*) are generally distinguished from *D. torulosa* by their hairless fruits or glandular-hairy stems and leaves. *Descurainia pinnata* has hairless, club-shaped fruit (Fertig et al. 1994, Fertig 1999, Dorn 2001). **Table 1** summarizes the diagnostic taxonomic traits and populations that show exceptions to the traits of *D. torulosa*.

Descurainia torulosa is sometimes sympatric with *D. incana*, a widespread circumboreal species, for example, at Togwotee Pass, the type location. The taxonomic relations between the two species were investigated in a DNA sequencing study conducted by Jerry Bricker and Gregory Brown of the University of Wyoming. This study indicated that *D. torulosa* is similar genetically to *D. incana*, and it should be recognized as a variety of the latter. The researchers concluded that any taxonomic revisions will require better clarification of species concepts and relationships within *Descurainia* (Bricker et al. 2000). Meanwhile, *D. torulosa* is addressed under current taxonomic treatments (Rollins 1993, Dorn 2001) and the working premise that it is distinct at some level (Dorn personal communication 2002).

The taxonomic relationships between the northern and southern populations of *Descurainia torulosa* were also investigated in the recent DNA research. Results indicated that southern populations sort out from northern ones, northern ones are more heterogeneous, and they are all part of a morphological complex that falls within the same clade but requires better clarification of species concepts and relationship within the genus *Descurainia* to resolve their taxonomic relationships and status (Bricker and Brown 1998, Bricker et al. 2000, Brown personal communication 2002). The information at hand does not rule out the possibility of polyphyletic origins of northern and southern populations as posited by Marriott (1991).

In summary, the circumscription of *Descurainia torulosa* needs review in combination with taxonomic research into appropriate levels of taxonomic treatment and the relations between northern and southern populations.

Table 1. Taxonomic characteristics of *Descurainia torulosa*.

Feature	Characteristic	Authority	Consistency among specimens
Silique shape	Torulose	Rollins 1983, 1993, Dorn 2001	Full gradient from slight to pronounced, as observed among all known *Descurainia torulosa* specimens by Bricker et al. 2000; not qualitatively different from *D. incana*.
Silique orientation	Appressed but sometimes flaring outward on top	Rollins 1983, 1993	Partial gradient from appressed to slightly divergent, as observed among all known *Descurainia torulosa* specimens by Bricker et al. 2000.
Silique surface	Pubescent	Dorn 1992, 2001, Rollins 1993	Pine Butte (EOR 003) had glabrous fruits.
Pedicel length	Equal or less than 2.5 mm	Rollins 1983, 1993, Dorn 2001	North Fork (EOR 004) had pedicels greater than 3 mm; Dorn (2001) uses the word "mostly"
Growth form	Procumbent	Rollins 1983, 1993	No consistency; specimens appeared to be erect to decumbent, as observed among all known *Descurainia torulosa* specimens by Bricker et al. 2000.
Life history	(Putative) perennial	Rollins 1983, 1993	Carter Mt. (EOR 002) specimen appeared to be annual, as do some plants from Pine Butte (EOR 003) and possibly a small number of plants in two northern populations, the latter observed among living *Descurainia torulosa* material in the field by Bricker et al. 2000.

History of the species

Descurainia torulosa is one of 13 North American species of *Descurainia* (Rollins 1993), a circumboreal genus with its center of distribution in North America. Unlike other circumboreal genera in the mustard family, the *Descurainia* genus includes several desert species. *Descurainia torulosa* is the only taxa in the genus with a limited geographic distribution, as indicated by state distribution patterns and state ranks (NatureServe 2002). There are four other *Descurainia* species in Wyoming, and several varieties (Dorn 2001). One of the species is introduced (*D. sophia*; Fertig 1999). Most native members of the genus increase under disturbance and are characterized as occupying "wastelands" (Taylor 1990).

Detling (1939) hypothesized that the *Descurainia* genus originated in the arid plateau regions to the south and east of the Great Basin, noting that the highlands of Arizona and New Mexico and the western slopes of the central Rocky Mountain cordillera are the regions of "the greatest concentration of distinct forms and the regions in which specific and subspecific characters appear still to be least constant in this genus." The most complete monographic work on the genus was by Detling (1939), work completed before the discovery of *D. torulosa*. The most current treatment of the genus, with revisions and additions, is presented in Rollins (1993).

The discovery and early documentation of *Descurainia torulosa* was summarized by Robert Dorn (1989) and is highlighted below. Dorn was also the first to question its taxonomic status and suggest that *D. torulosa* might be just a form of *D. incana*, a common, widespread species (Dorn 1989). The first collection of *D. torulosa* was made on July 8, 1966 by Richard W. Scott in the southern Absaroka Mountains near Brooks Lake in Fremont County, Wyoming (Scott 761 holotype, GH) on Shoshone National Forest (Region 2). It was described by Reed Rollins of Harvard University in 1983 based on the type specimen. Keith Dueholm of the University of Wyoming collected material on Pine Butte in Sweetwater County, Wyoming in 1980 that was unknown to Rollins when the species was described. Rob Kirkpatrick, a student at the University of Wyoming, discovered another population in the Absaroka Mountains of Park County in 1984. Erwin Evert collected *D. torulosa* at another site in the same range in 1986. The collections through 1989 were summarized by Robert Dorn (1989), and inventory was

conducted. In 1990, Hollis Marriott and Al Flinck of the Wyoming Natural Diversity Database (WYNDD) surveyed for it in the Bridger-Teton National Forest as well as re-collected it at the Pine Butte site. All of these collections were reviewed by Rollins, expert in the mustard family (Brassicaceae; or Cruciferae), who determined them as "*Descurainia torulosa* (?)" but differing from the type specimen and published description in one or more characteristics.

In 1993, Reed Rollins published the definitive treatise on the mustard family (Brassicaceae; or Cruciferae) of North America, and he wrote that *Descurainia torulosa* is "Known to me only from the type collection," not recognizing the other collections (Rollins 1993).

The 1990 survey by Hollis Marriott and Al Flinck of *Descurainia torulosa* was conducted on the Bridger-Teton National Forest after completing aerial reconnaissance of the entire Wind River District. They focused on the Brooks Lake, Togwotee Pass, Pinnacle Butte areas, and Five Pockets areas (Marriott 1991). Also in 1990, Erwin Evert collected it in the Shoshone National Forest. The 1991 survey by Marriott and Flinck was conducted on BLM lands in the Pine Butte and Lions Bluff areas in Sweetwater County, the "southern" population area. The only subsequent new collection site of *D. torulosa* was represented by a collection made by Ronald Hartman in 1996, in the southern Absaroka Mountains on Shoshone National Forest.

Marriott (1992) raised the questions in status reports whether *Descurainia torulosa* is appropriate to recognize at the species level, and whether northern and southern populations belong to the same taxon. Genetics research and morphological analysis were initiated in 1997 by Bricker and Brown (1998) to answer these questions using leaf material collected in the field. They published their results to date in Bricker et al. (2000).

Distribution and abundance

Descurainia torulosa is a state endemic restricted to the southern Absaroka Range in Fremont, Park, and Teton counties, and to the Rock Springs Uplift in Sweetwater County, Wyoming (**Figure 3**; Clark et al. 1989, Dorn 1989, Marriott 1991, Fertig 1992a, Fertig 1992b, Marriott 1992, Fertig et al. 1994, Snow 1994, Mills and Fertig 1996, Croft et al. 1997, Fertig 1997, Scott 1997, Fertig 1998, Rosenthal 1998, Ward 1998, Rosenthal 1999, Fertig 2000, Welp et al. 2000, Dorn 2001, Hartman and Nelson 2003). All Region 2 populations are in the Absaroka Range on Shoshone National Forest. All Region 4 populations are in the Absaroka Range near a Region 2 population. One additional BLM population is near the Shoshone National Forest. These collectively represent the Absaroka Range populations. The populations in the Absaroka Range and the two BLM populations in the Rock Springs Uplift are about 180 miles (288 km) apart. The intervening landscape is part of the Great Divide Basin, much of which had been flooded by Lake Gosiute during the Eocene Epoch (Lageson and Spearing 1988). This bimodal pattern represents an unusual distribution among the state and regional vascular plant endemics found in Wyoming. Throughout the rest of this document, reference to the northern populations pertains to Region 2 populations unless otherwise stated, and reference to southern populations pertains to BLM populations.

The species is known from 9 to 12 occurrences, depending on how they are delimited. There are four occurrences in an area of less than 10 square miles that might be better treated as one metapopulation rather than four separate occurrences (Marriott 1991). This cluster includes one Region 2 occurrence and all three Region 4 occurrences, located in the Brooks Lake - Togwotee Pass area in Fremont and Teton counties (element occurrence records (EORs) 001, 005, 006, 007) in an area straddling the Continental Divide.

This tally of occurrences also depends on verification of specimens from three additional occurrences that have been questioned over the years in applying the original species description based on the type specimen (Rollins 1983). The specimens from Carter Mountain (Park County; EOR 002) are annual, the specimens from Pine Butte have glabrous fruit (Sweetwater County, EOR 003), and the specimens from North Fork of the Shoshone River (Park County, EOR 004) have pedicels over 3 mm long (up to 6 mm). Rollins (1993) recognized only the type population (Brooks Lake, Fremont County) as authentic. Identification of the 1984 specimen from Carter Mountain is particularly questionable because the specimen is immature, and only *Descurainia incana* was found by Dorn when he tried to relocate it (Dorn 1989).

There have been three systematic inventories of *Descurainia torulosa*, including surveys by Robert Dorn to sites that included Brooks Lake on Shoshone National Forest (Dorn 1989), and two other inventories outside of Region 2 (Marriott 1991, 1992). The latter inventories involved use of aerial reconnaissance prior to field inventory on foot by a team of field researchers. Each of the past inventories noted that there was potentially suitable habitat that was not accessible on

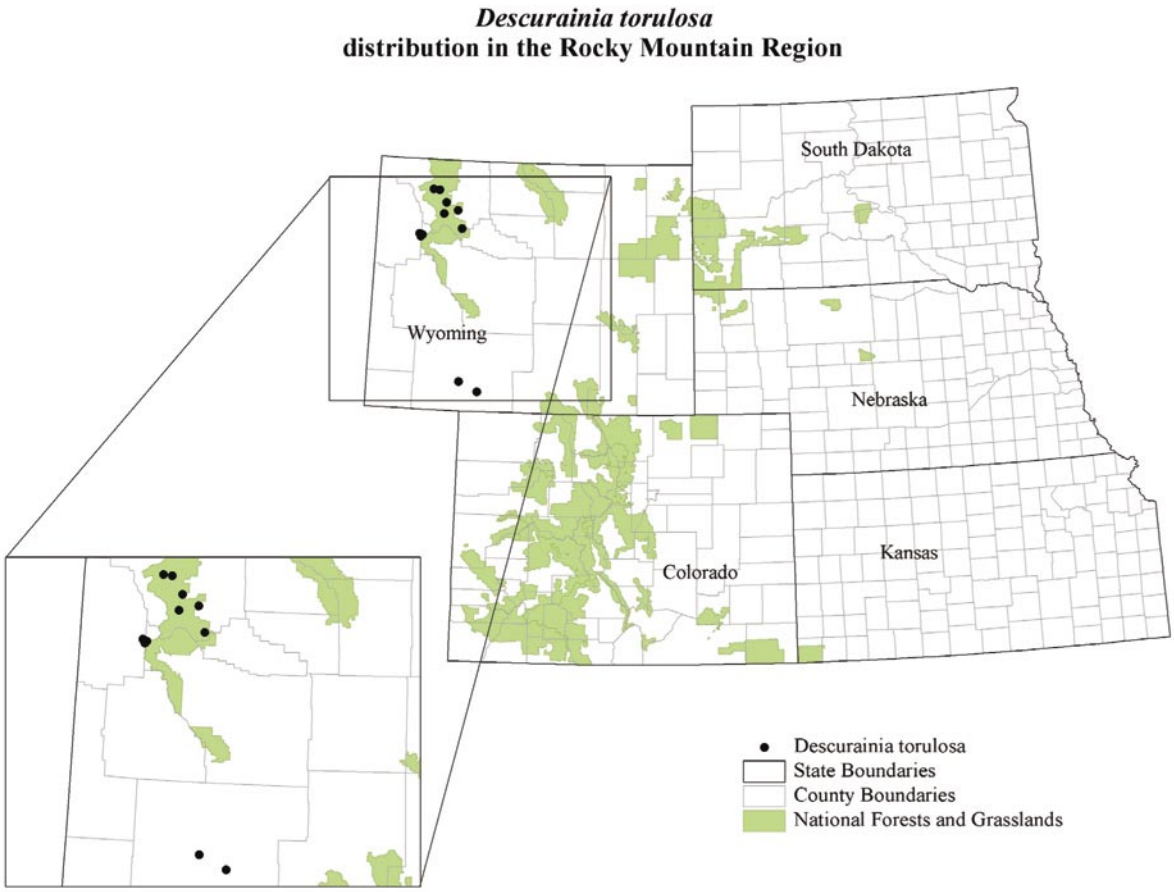

Figure 3. Rangewide distribution of *Descurainia torulosa*. The species is only known from Wyoming and does not occur in any other states of Region 2 (Colorado, Kansas, Nebraska, South Dakota).

the sheer cliff faces (Dorn 1989, Marriott 1991, 1992). There is a major, inherent limitation on the ability for investigators to inventory unstable cliff habitat. Rockslide and rockfall are cited as survey hazards, and helmets were routine field gear.

A model of species' potential distribution has identified areas of high, medium, and low probability of finding suitable habitat (**Figure 4**; from Fertig and Thurston 2003). Available distribution data were used, as well as negative data where the species is not known to occur. The available environmental attributes that correlate most closely with current distribution for use in identifying potential distribution in the "classification tree" were surface geology (Absaroka volcanics) and elevation (subalpine-alpine) for northern occurrences, a negative correlation with mean monthly January temperatures for northern occurrences, a positive correlation with April precipitation for southern occurrences, and direct correlation with rocky, barren land cover and with topographic relief for both sets of occurrences.

This analysis suggests that there is additional habitat in Region 2, and that there may be suitable habitat where there are no known populations, e.g. in the Wind River Range. Small areas with low probabilities of potential habitat are identified elsewhere on national forests in Region 2, including Bighorn National Forest and Medicine Bow National Forest. This model of potential distribution is best used for surveys and project reviews in combination with topographic maps, geologic maps, known distribution maps, discussions with knowledgeable people, and visits to known sites. It is a systematic extrapolation from the coarse level of environmental attributes used in this particular modeling project. The results do not replace surveys and should not be distributed without accompanying reference to the complete modeling report and disclaimers.

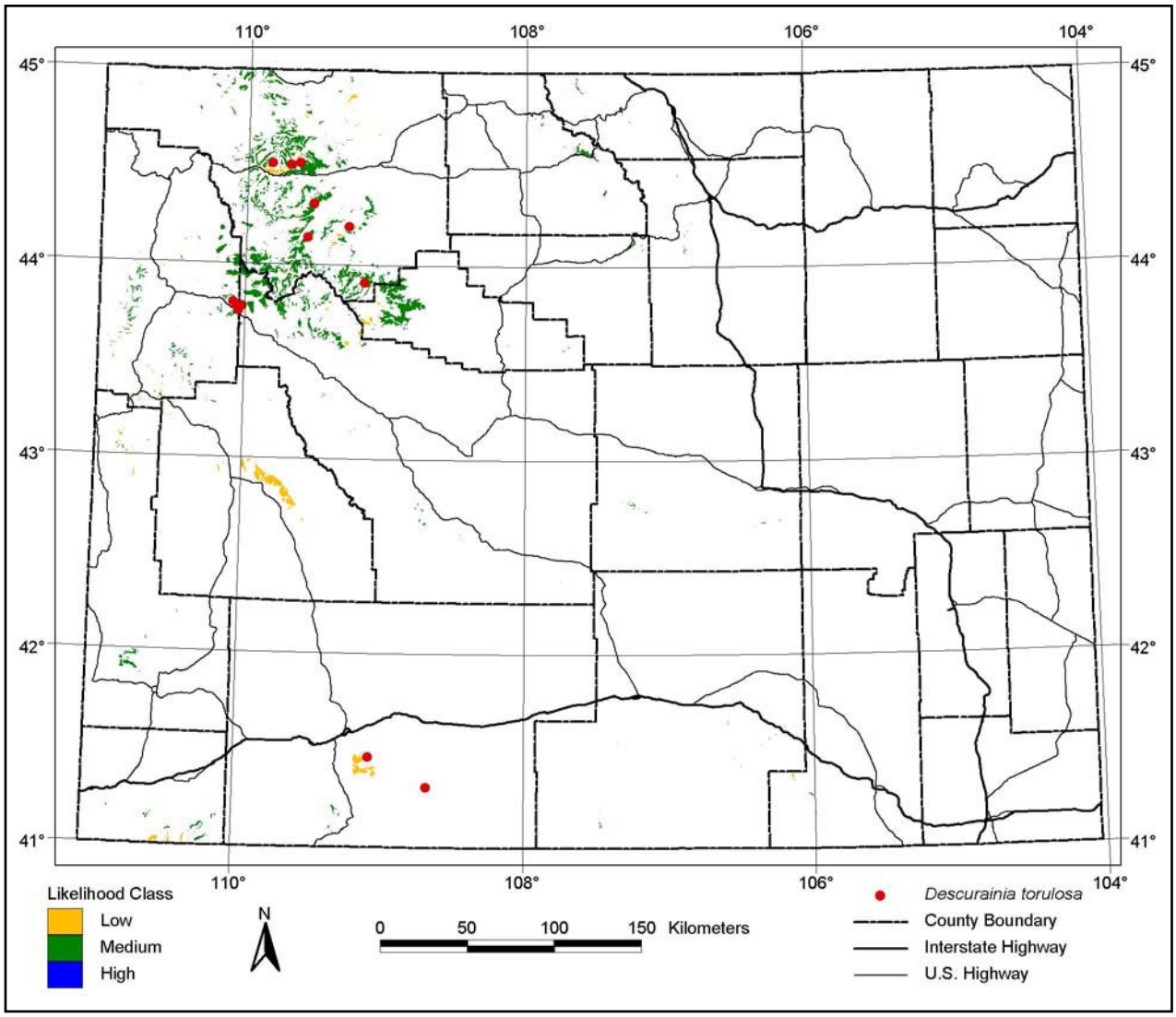

Figure 4. Potential distribution of *Descurainia torulosa* (Fertig, W. and R. Thurston. 2003. Modeling the Potential Distribution of BLM sensitive and USFWS Threatened and Endangered Plant Species in Wyoming (http://uwadmnweb.uwyo.edu/WYNDD/Reports/pdf_fertig/FinalReport_03BLMmodeling.pdf). Report prepared for the BLM – Wyoming State Office by WYNDD – University of Wyoming, Laramie, WY).

The cumulative rangewide population numbers of *Descurainia torulosa* were at least 1090 fruiting and flowering plants at one point in time, not counting 820 plants that were vegetative or otherwise not taxonomically confirmed (**Table 2**). This total includes the highest values for those populations with more than one year of census data. The populations with the largest known numbers have been documented in the two southern populations. Most northern populations average less than 40 flowering and fruiting individuals and may be restricted to a single ledge. Half of the populations (6 of 12) do not have population size estimates, and most of these are in Region 2 (5 of 6). Total numbers range-wide were estimated at less than 1500 flowering and fruiting individuals (Marriott 1991, 1992, Fertig 1997). The tally from uncensused occurrences and a tally that included vegetative plants would increase this total.

Each of the known populations spans less than 0.5 miles and has varying degrees of continuity or discontinuity. The total extent of populations has been digitized from field maps and is estimated at much less than 12 ha. All populations that included estimates of population extent had values less than 1 acre, for a total of less than 4.8 ha (12 acres). Two occurrences have been digitized as spanning more than 1 hectare, Pine Butte EOR 003 (2.3 ha) and the North Fork of the Shoshone

Table 2. Summary information for *Descurainia torulosa* occurrences in Wyoming. Includes element occurrence record number, location, county, date of estimate, estimated abundance, and estimated area. Location names that are bold-faced are on the Shoshone National Forest.

Element Occurrence Record	Location	County	Date of Estimate	Estimated Abundance	Estimated Area
001	**Togwotee Pass**	Fremont	1996	Six reproductive plants plus 75 to 100 vegetative plants; possibly 150 more total in 2nd colony not confirmed ID; plus one to three other colonies that could not be relocated.	Less than 1
002	Carter Mountain	Park	Not Available (NA)	No information on number of plants or suboccurrences.	Less than 1
003	Pine Butte	Sweetwater	1991	137 reproductive plus 260 to 520 vegetative that are likely to be *Descurainia torulosa*.	Less than 1
004	**North Fork Shoshone River drainage**	Park	NA	"small" population.	Less than 1
005	Sublette Ridge	Teton	1990	19 reproductive plus unknown number of vegetative.	Less than 1
006	Breccia Cliffs, east end	Teton	1990	12 reproductive plus approximately 50 vegetative.	Less than 1
007	Breccia Cliffs, west end	Teton	1990	26 reproductive.	Less than 1
008	Lions Bluff	Sweetwater	1991	890 reproductive.	Less than 1
009	**Hunter Creek**	Park	NA	No information on number of plants or suboccurrences.	Less than 1
010	**Beaver Creek**	Park	NA	No information on number of plants or suboccurrences.	Less than 1
011	**Wapiti Ridge, east of**	Park	NA	No information on number of plants or suboccurrences.	Less than 1
012	**Buttress Mountain, east of**	Park	NA	No information on number of plants or suboccurrences.	Less than 1
Total				1090 reproductive plus at least 385 vegetative.	Less than 12

River EOR 004 (4.4 ha in two subpopulations), but they were estimated in the field as less than an acre (0.4 ha). All estimates and mapping are likely to be an overestimation of population extent because the species is usually in a zone of habitat that is extremely narrow, and for all practical purposes represented as broken lines. The boundaries drawn for Bridger-Teton National Forest populations that occur across different slopes and aspects are much greater on the map than the actual occupied habitat. Summaries of population estimates and population extent are presented in **Table 2**.

Population trend

Trend data are lacking for all populations of *Descurainia torulosa*. Two populations were surveyed more than once over time, but they were not surveyed in consecutive years or by the same investigators. At

Pine Butte, the number of plants in flower or fruit ranged from 150 in 1987 to nine in 1989, and back up to 137 in 1991, indicating fluctuating numbers and at least short-term persistence. At the type location above Brooks Lake, the number of flowering individuals varied from 25 in 1989, 38 in 1990, to 6 in 1996; the most recent figure may represent census information from a different colony or subcolony. The data should be considered preliminary because investigators did not have the benefit of precise location information.

Interpretation of trend data is further constrained by incompleteness of censuses and of the life history data as it pertains to vegetative plants. Population counts and estimates consistently include reproductive (flowering and fruiting) plant numbers. However, they do not consistently address vegetative plant numbers, which are more difficult to discern and census. More importantly, vegetative *Descurainia torulosa* plants cannot be differentiated from the closely related *D. incana* that grows with *D. torulosa* in at least the type locale that has repeated population estimates. Even if a complete census of all reproductive plants were available for all populations in consecutive years, it may not be adequate for trend determination unless we knew more about the species life cycle. There are site-specific reports that *D. torulosa* is an annual, a biennial, and a short-lived perennial (discussed in detail under demography), and this could be fixed or variable at any given site. Interpretation of any census is also incomplete without knowing whether there is a seedbank, which could produce surges of vegetative plants under conditions favorable for germination. The proportion of vegetative vs. flowering plants would be expected to vary annually if there is a seedbank or if there is life history plasticity.

In addition, interpretation of trend data is complicated by the affects of drought. Dorn (1989) stated that species population vigor was considered poor. He based this assessment on the low numbers in his 1989 survey work, a drought year. The Pine Butte trend data (above) may reflect decline under the 1988-89 drought. More recent follow-up surveys in the southern occurrences of the BLM Rock Springs Field Office supported this interpretation that declines were linked to drought conditions (Amidon personal communication to Walter Fertig prior to 1998).

Short-term fluctuations in species numbers may correspond with climate conditions in general. Winter precipitation (snowfall) is a primary source of moisture and may also be critical to germination, rosette survival, and flowering. This is consistent with the observation of Dorn (1989) that the species occupies microhabitats that are relatively cool and moist and with the observations and photographs of Marriott et al. (1991) that these areas often hold snowpack until mid- or late-summer. Previous investigators hypothesized that snowfall conditions shape habitat suitability in the Absaroka Mountains (Dorn 1989, Marriott 1991). Several habitat photos by Marriott show snowfall persisting in late July (**Figure 5**). It is also consistent with the modeling of species' potential distribution in which January mean monthly temperatures was an environmental variable that showed high correlation with species' distribution (Fertig and Thurston 2002). Monthly snow-water equivalent data from the Absaroka Mountains (Togwotee Pass) are posted by the USDA Natural Resource Conservation Service (2002) and show annual values approaching a two-fold difference between years. Microhabitat differences that correspond with patterns of snowfall accumulation are likely to amplify climate differences. Snowfall monitoring data are not available for southern populations in the Rock Springs Uplift area.

Habitat

Descurainia torulosa is associated with steep cliffs, occurring on sandy substrate often at the interface between cliff faces and the talus slopes below, or on ledges. It is sometimes restricted to slight overhangs or in cavities (Marriott 1991). Soil particles and snowfall accumulate in these localized settings. Aspect varies from southwest to south to east to north, but the settings are usually shady or sheltered and not exposed to full sun or directly exposed to wind. Slopes range from 5 to 30 degrees. In general, the species is a pioneer or early succession species of semi-stable cliff habitat (Dorn 1989, Marriott 1991, 1992, Fertig 1995, 2000). The requirement for relatively high elevations and north-facing sites in the Rock Springs Uplift has been interpreted as an indication that *D. torulosa* populations there are relics of cooler times, when the species' distribution was more continuous (Marriott 1991).

There are major contrasts in landscape settings between the northern occurrences (occurrences that fall on national forests of Region 2 and Region 4) and the two southern populations on BLM lands (within Region 4 but distant from any national forests). The northern populations are in montane and subalpine zones of the Absaroka Mountains (**Figure 5**). The southern populations are on escarpments of the Rock Springs Uplift in cold desert plains (**Figure 6**). The northwest Wyoming populations have about 20 to 24 inches of mean annual precipitation, and the populations in

Figure 5. Habitat of *Descurainia torulosa*, southern Absaroka Range, by Hollis Marriott. (Arrow points to habitat.)

Figure 6. Habitat of *Descurainia torulosa*, Pine Butte, by Hollis Marriott. (Arrow points to habitat.)

southwestern Wyoming have about 10 inches of mean annual precipitation (Dorn 1989). There is an overlap in elevation. Elevations range from 7,200 to 10,500 ft. in the northern populations, and from 8,300 to 8,500 ft in the southern populations.

The parent materials are coarse, often platy, and they exfoliate. Absaroka Range populations are on the Wiggins Formation of Eocene Age, within the Absaroka Volcanic Supergroup of Eocene age, or on the Wapiti Formation, also of Eocene age (Love and Christiansen 1985, from Dorn 1989). In both formations, *Descurainia torulosa* occurs specifically on sandy layers within the volcanic breccia. The Pine Butte population of *D. torulosa* is on the Sand Butte bed of the Laney shale member of the Green River Formation, also Eocene age (Pierce 1978, from Dorn 1989). The Lions Bluff population is on Miocene sandstone of the Southern Rock Springs Uplift (Love and Christiansen 1985, from Dorn 1989). Despite the difference in geological formations between northern and southern populations, all populations are on sandy substrate with little or no soil profile development, and with very low organic content and unconsolidated soil structure, but with soil depth and moisture content higher than in the surroundings.

Descurainia torulosa occupies sparsely vegetated habitat with other herbaceous species. Some of the most frequently associated species in the northern population sites are *Achillea millefolium* (western yarrow), *Erigeron compositus* (cut-leaved daisy), *Oxyria digyna* (mountain sorrel), *Phacelia hastata* (silver-leaf scorpion-weed), *Polygonum douglasii* (Douglas' knotweed), and *Senecio werneriifolius* (Rocky alpine groundsel). Associated species in the southern population sites include *Arenaria nuttallii* (brittle stitchwort), *Atriplex* species (saltbush species), *Chenopodium atrovirens* (pinyon goosefoot), *Cryptantha watsonii* (Watson's cat's-eye), *Oenothera caespitosa* (tufted evening-primose), and *Phacelia* species (phacelia species). The presence of "thin humus and some cryptogam crust" was mentioned at the Brooks Lake site, but no other information on nonvascular plants is available.

The Carter Mountain specimen of *Descurainia torulosa* (Kirkpatrick 5049) is reported from "montane riparian sand and gravel bars". This is an immature specimen that cannot be verified using characteristics of the silique. It represents the only known record from a riparian corridor setting. Species that grow on rock outcrops are occasionally present in early-succession riparian settings below the outcrops, but the riparian habitat is not characteristic of the species even if the identification is correct.

Habitat generalizations have been developed for *Descurainia torulosa* from status reports (Marriott 1991, 1992), collection labels, and the species potential distribution model (Fertig and Thurston 2003). All of the records with detailed habitat information indicate that the species is associated with cliff faces and early-succession species, typically in sheltered microhabitats. The critical nature of available moisture is suggested by the correlation between species distribution and April precipitation for southern populations, and between species distribution and low January temperatures for northern populations, if one assumes that snow accumulation and retention is closely linked to low January temperatures. The common habitat requirements are presented as resources in an envirogram (**Figure 7**), and a comparison of habitat similarities and contrasts between occurrences are presented in **Table 3**.

The habitat of *Descurainia torulosa* is intrinsically unstable. The thin zone at the base of cliff faces fringed by talus slopes appears to be a setting where shifting, burial, or uprooting of plants from rockfalls and rockslides is recurrent and the forces of erosion are ongoing. If such zones become stable, then vegetation encroachment is possible. The history and likelihood of rockslides at any of the known occurrences is not known. In places where surveys have been conducted, it is sometimes noted that there is much apparently suitable habitat in the area that is not occupied, indicating high frequency disturbance, suitable but unoccupied habitat, or the possibility that all microhabitat requirements are not defined or apparent at the time of survey. The species may be dependent on some level of natural disturbances for colonization of new sites and for survival at existing sites (Fertig 1995).

Reproductive biology and autecology

Descurainia torulosa flowers in mid-summer. It has been collected in fruit with or without flowers as early as July 8, and as late as September 3. It has an indeterminate inflorescence, and flowering is prolonged under suitable conditions. It grows in areas of persisting snow banks, so the phenology varies in years of unusually early or late snowmelt conditions. Fruits mature in three to four weeks (Dorn 1989). It is likely, but not documented, that the preceding year's snowfall levels as well as population age structure affect the proportion of plants that flower in any given year.

The inconspicuous flowers have the basic floral structure that is highly characteristic and constant in the Brassicaceae, containing four sepals, four petals, six stamens (four long and two short stamens), and

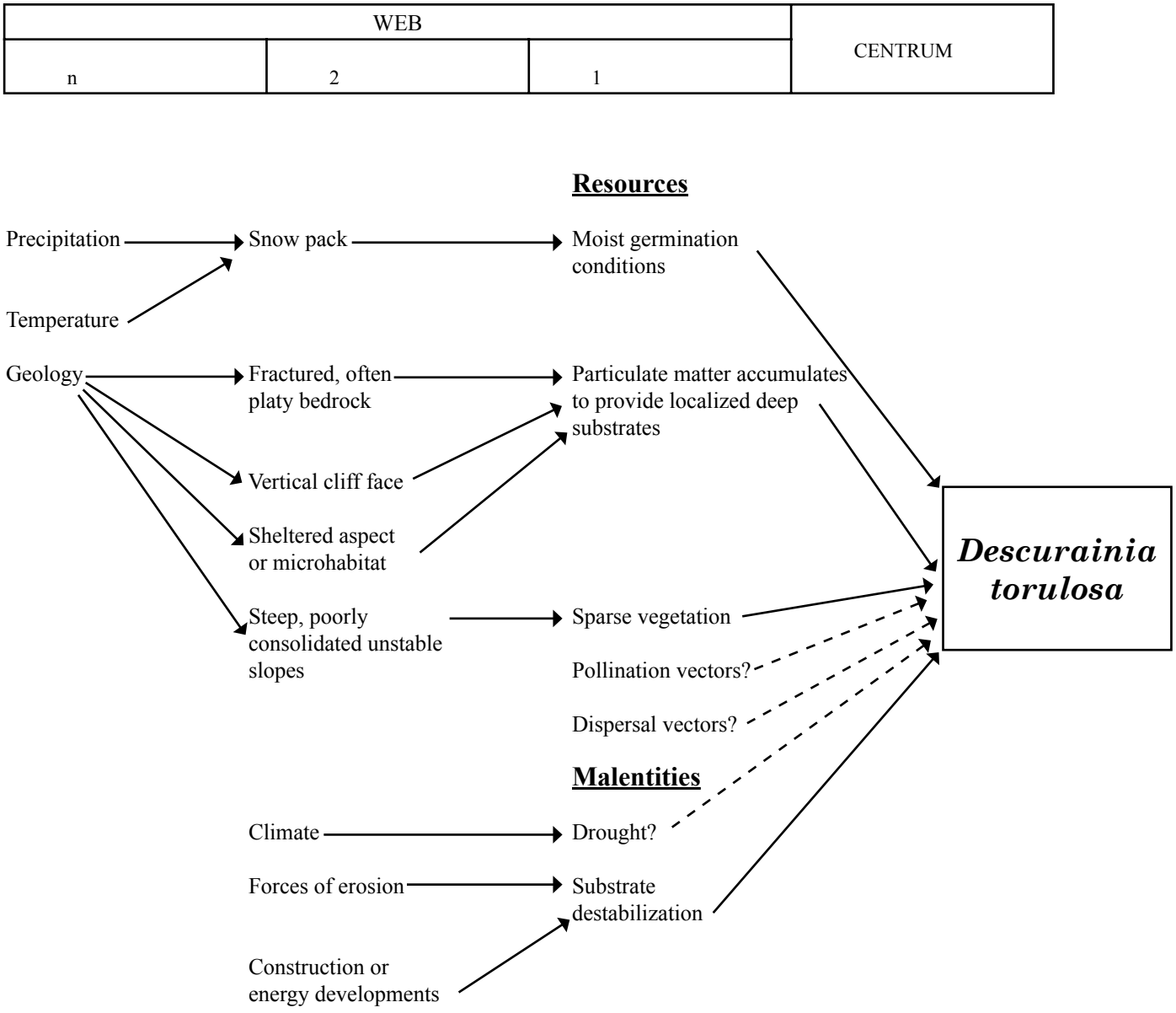

Figure 7. Envirogram of key resources and malentities for *Descurainia torulosa*. Dashed lines indicate resources or malentities that are likely but not proven key variables.

Table 3. Habitat information for 12 *Descurainia torulosa* occurrences in Wyoming. Includes element occurrence record number, location, county, setting, elevation range, general habitat description, and associated plant species information. Locations that are bold-faced are on the Shoshone National Forest.

Element Occurrence Record	Location	County	Setting	Elevation Range (ft)	General Habitat Description	Associated Plant Species
001	**Togwotee Pass**	Fremont	Absaroka Range	10,080 to 10,280	Semi-shady alcoves at base of east-facing cliffs at top of scree slope and on ledges of lower cliffs on light-colored, fine, sparsely-vegetated soil derived from a layer in the Wiggins Formation; with thin humus and some cryptogam crusts.	*Oxyria digyna*, *Arnica longifolia*, *Achillea millefolium*
002	Carter Mountain	Park	Absaroka Range	9,800	Alpine scree and talus slopes with rocky outcrops.	No information
003	Pine Butte	Sweetwater	Rock Springs Uplift	8,500	Sandy soil at base of north- and northwest-facing sandstone cliff and among talus on uppermost talus slope.	*Cryptantha watsonii*, *Phacelia* spp., *Arenaria nuttallii*, *Oenothera cespitosa*
004	**North Fork Shoshone River drainage**	Park	Absaroka Range	7,200 to 8,000	Open rocky barren ridge with numerous pinnacles and open, rocky habitats with scattered Douglas-fir and limber pine.	No information
005	Sublette Ridge	Teton	Absaroka Range	10,400	Base of cliff at top of scree slope on a soft, light-colored, fine, sparsely-vegetated soil derived from a layer in the Wiggins Formation.	*Mimulus* spp., *Antennaria* spp., *Achillea millefolium*, *Erigeron compositus*
006	Breccia Cliffs, east end	Teton	Absaroka Range	10,100	Base of cliffs at top of scree slope on sparsely-vegetated fine, light-colored soil derived from a layer in the Wiggins Formation.	*Oxyria digyna*, *Chenopodium* spp., *Leucopoa kingii*, *Achillea millefolium*, *Phacelia* spp., *Cirsium* spp.
007	Breccia Cliffs, west end	Teton	Absaroka Range	10,500	Base of cliffs at top of scree slope on sparsely-vegetated, light-colored fine soil derived from a layer in the Wiggins Formation.	*Oxyria digyna*, *Eriogonum* spp., *Erigeron compositus*
008	Lions Bluff	Sweetwater	Rock Springs Uplift	8,300 to 8,400	In talus/scree at base of sandstone cliff along margins of couloirs on north-facing exposure.	*Cryptantha* spp., *Atriplex* spp.
009	**Hunter Creek**	Park	Absaroka Range	8,800	Sparsely-vegetated talus slope.	*Rubus idaeus*, *Hulsea algida*
010	**Beaver Creek**	Park	Absaroka Range	7,500	Montane riparian sand and gravel bars	No information
011	**Wapiti Ridge, east of**	Park	Absaroka Range	8,000 to 9,000	On volcanic rocky ridgetop.	No information
012	**Buttress Mountain, east of**	Park	Absaroka Range	10,300	Among boulders on ridgetop in fellfield cushion plant community.	*Phacelia hastata*, *Senecio werneriifolius*

an ovary with two parietal placenta (Hickey and King 1981). Pollination in most members of the Brassicaceae is accomplished by nectar secretions into the bases of the pouched sepals that attracts insects and promotes cross-pollination; however, self-pollination of the flowers is a frequent occurrence (Hickey and King 1981). Insect visitors have not been noted on *Descurainia torulosa*.

Seeds in the genus are mucilaginous when wet (Detling 1939) and remain sticky after absorbing moisture (Rollins 1993). In general, dispersal would be expected to be over short distances when assisted by wind and water (Dorn 1989), but seeds may cover greater distances if animal dispersal vectors are involved.

Hybridization has not been documented in the genus. The closely-related *Descurainia incana* is sympatric with some of the northern and southern populations. It cannot be reliably distinguished from *D. torulosa* except in fruit. There have not been greenhouse studies to determine whether *D. torulosa* can be cross-pollinated with *D. incana*.

The species appears to be a pioneer species and is consistently found in low vegetation cover (discussed further under Community ecology). There is no information available on dispersal, germination, and establishment.

The possibility that this species self-fertilizes may have viability implications. Greenhouse studies are needed to determine the feasibility, and if there is self-fertilization, the change to seed viability that results. If seed viability is not significantly reduced with self-fertilization, then there is limited need to pursue research into population genetics. If seed viability is reduced, then genetic research might be pursued to determine levels of selfing in representative northern and southern populations, and entomologists could be consulted on prospective baseline pollination research.

Chromosome data are not available. The widespread European species *Descurainia sophia* has a base chromosome number of 2n=14, but most chromosome counts are polyploidy (2n=28; Missouri Botanical Garden 2003). Research into the chromosome number of *D. torulosa* and of the most closely related varieties of *D. incana* may provide insights into evolutionary relationships.

Demography

The four stages of *Descurainia torulosa* life history are seed, seedling, vegetative rosette, and flowering plant (**Figure 8**). The average rates and variables in transitions between stages are undetermined. It is possible that the species can produce flowering stems in one year under some conditions, as in the case of the voucher specimens from the BLM populations including one northern population (Carter Mountain; Park County) and the two southern populations (Pine Butte and Lion's Bluff; Sweetwater County). Perhaps *D. torulosa* has this capacity as a "winter annual", i.e., germinating in fall, overwintering under snowbanks, and having the capacity to flower in the first growing season.

Most populations of *Descurainia torulosa* are thought to take two or more years to produce flowering stems as biennials or short-lived perennials. Seedlings develop into a cluster of basal leaves, i.e., vegetative rosettes, a stage that might extend for more than one year. The species only produces flowers once and then dies, that is, it is semelparous. From the available set of observations, it is not known if and how the life cycle differs between sites, between years, and within populations.

In addition to the seedling, basal rosette, and flowering plant stages, there may be a seedbank stage involving seeds that remain dormant through at least one full year. As a short-lived species in a harsh environment, *Descurainia torulosa* fits the pattern of species that benefit from having a seedbank, i.e., short life cycle and fluctuating environmental conditions that can be harsh (Rees 1994). In these settings, a seedbank provides a buffer against adverse conditions and a capacity to take advantage of favorable conditions. If it has a seedbank, then it would be appropriate to evaluate what proportion of the seeds produced are dormant or nondormant, how long seeds in the seedbank can remain viable, and what the mechanisms are for breaking dormancy.

Habitat availability and colonization ability may be the primary factors limiting population numbers and growth, unless the spatial/temporal patterns of disturbance are limiting.

The seeds of *Descurainia torulosa* are not archived, though Denver Botanic Gardens has already been designated as the repository for this species by Center for Plant Conservation. Earlier genetics research was based on transplanted individuals, and seed propagation techniques have not been developed. Seed collection might be included in fieldwork objectives.

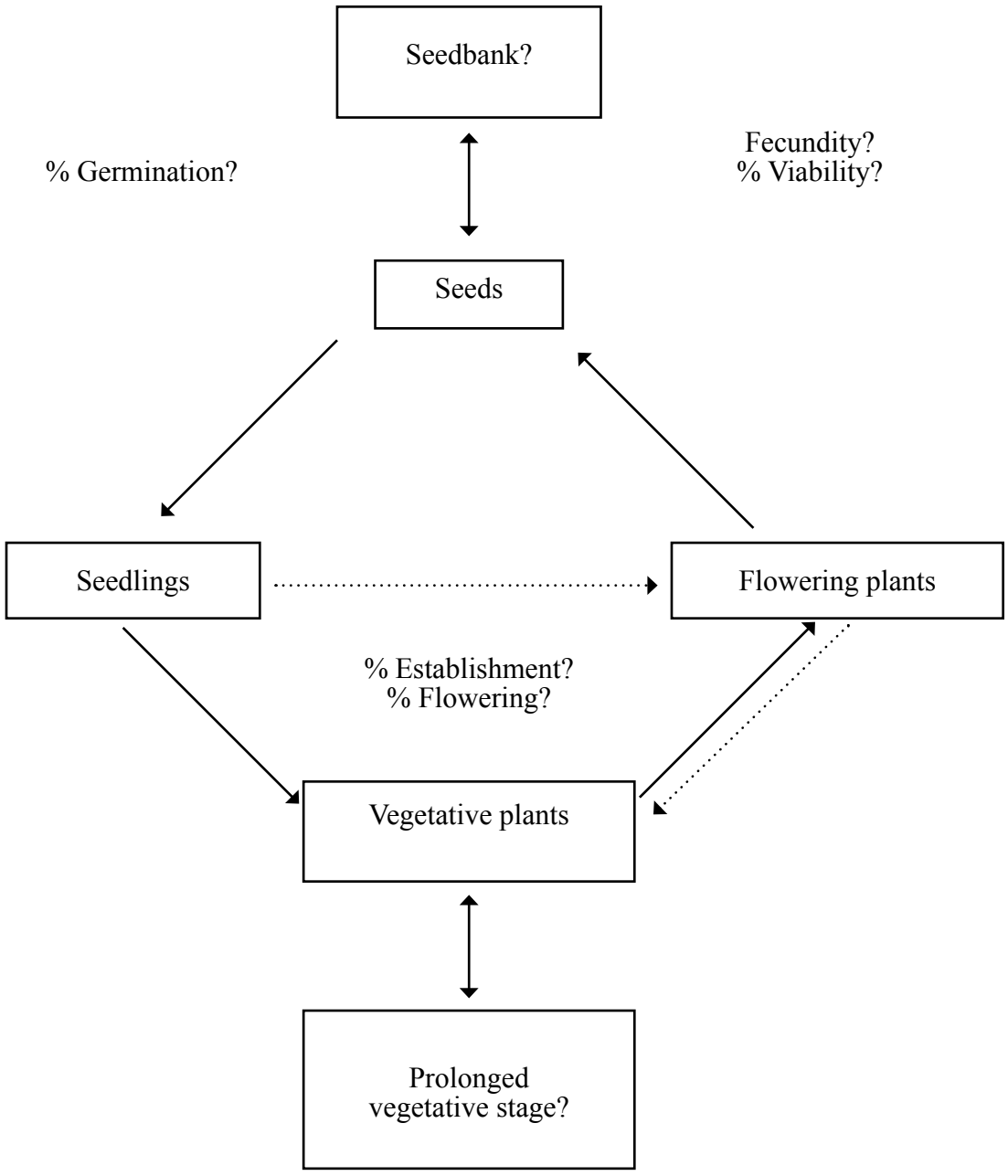

Figure 8. Life cycle diagram for *Descurainia torulosa*.

Community ecology

There have been occasional signs of herbivory, but no signs of disease or symbiotic relations were noted during surveys and in review of Rocky Mountain Herbarium specimens. It was speculated that the occasional herbivory may be browse by pikas (Dorn 1989). Other members of the genus have been documented as larval food plants for lepidopterans in Europe, including *Anthocharis cethura* and *Pontia chloridice* on the *Descurainia* genus, and *Euchloe austonides* on the related *D. incana* (Anonymous 2002). There are no known mutualistic interactions.

Members of the mustard family are not known to have mycorrhizal relations (Miller personal communication 2002). *Descurainia torulosa* appears to be a pioneer species and is consistently found in low vegetation cover. Among the first plants to stabilize such settings are graminoids that reproduce vegetatively and shrubs that overshadow herbaceous vegetation. *Descurainia torulosa* does not occur with such species and is likely to be a poor competitor.

CONSERVATION

Threats

Descurainia torulosa occurs in remote settings that are rugged and difficult to access. Populations have no known direct man-made threats. However, the localized habitat is potentially impacted by destabilization of the cliff face high above or the talus slope far below. Road building and telecommunication facilities development, or (on BLM lands) seismic activities and other oil and gas developments may also destabilize the species' habitat, even though the activities do not take place at the cliff faces and talus slopes. There are no public roads or energy developments around known populations at present, with two exceptions outside of Region 2. The only facilities in the vicinity of known populations are a telecommunications station high above the Sublette Ridge population in Bridger-Teton National Forest (EOR 005) and a telecommunications station on Lion's Bluff population, Rock Springs Field Office, that is not directly above the population (EOR 008). Oil and gas drilling were considered potential threats near BLM occurrences (Dorn 1989), but ACEC designation was established to protect the species.

Most land in the area of northern populations is used for non-motorized recreation. While some is part of grazing leases, the species' habitat is largely inaccessible for direct use by livestock or recreationalists (Dorn 1989). Livestock management and recreational uses do not directly affect the species or its habitat, unless they introduce exotic species into surrounding terrain or destabilize the habitat on a small scale. The species was given a low vulnerability rating in evaluating the potential vulnerability of Shoshone National Forest sensitive plant species to livestock grazing due to the inaccessibility of its habitat (Fertig 1995). Some sites could potentially be impacted by competition from exotic plants if developments or management actions result in their introduction and spread into the landscape and then dissemination into species' habitat. Exotic species have not been noted in surveys and specimen label information to date. The lowest elevation population, the North Fork of the Shoshone River in Region 2, is probably the most vulnerable to invasion, and perhaps naturalized exotics like *Poa pratensis* (Kentucky bluegrass) are more of a threat through competition than noxious weeds. One Shoshone National Forest population directly adjoins a pack trail, the Hunter Creek (Boulder Basin) pack trail, but the prospects of off-trail impacts are unlikely in the rugged terrain (Houston personal communication 2002).

There are no known consumptive uses of *Descurainia torulosa* for commercial, recreational, scientific, or educational purposes.

Descurainia torulosa may be vulnerable to extinction because of its naturally low population size and limited habitat. Such vulnerability may be exacerbated by climate (e.g., a series of low-snowfall years), especially if the seedbank is short-lived. The trend data from a southern population suggest that these southern populations declined significantly under drought. The natural disturbance of chance rockfall and rockslide events could also threaten populations. It would be useful background information to know which populations are located near active fault lines. While there are no options for ameliorating harsh habitat conditions and chance environmental events, information on species vulnerability would elevate the priority placed on *ex situ* conservation and in setting site conservation priorities. A summary of prospective threats to *D. torulosa* is included in the envirogram (**Figure 7**).

Apart from these environmental factors, low population numbers and reproductive biology alone may signify high vulnerability. What are the minimum population viability requirements of *Descurainia torulosa*? Minimum viable populations are often on the order of 1000 to 100,000 individuals according to

Menges (1991), and shorter-lived species generally have higher minimum population requirements than longer-lived species. The documented population numbers of *D. torulosa* are all below this range. The small aerial extent of populations and the potential that this species self-fertilizes means that the effective genome diversity for plants that grow together may be very low. With the apparently low numbers, a premium should be placed on maintaining populations of *D. torulosa* throughout its range. The greatest numbers of populations are in the Absaroka Range, and the Shoshone National Forest in particular, while the greatest numbers of individuals are present in the two southern populations outside of Region 2. Key pieces of information are needed before population viability analysis can be considered, including population locations, numbers, life history, and the taxonomic relation between northern and southern populations.

Conservation Status in Region 2

Descurainia torulosa is often in remote settings that are extremely rugged, have few direct threats, and are relatively inaccessible. It is a short-lived species confined to a narrow zone in an unstable habitat, affected by chance disturbance events, with high vulnerability even without human-caused threats. Half of its known populations are in wilderness areas or designated Areas of Critical Environmental Concern. While there have been no cases of proposed projects and management actions affecting the species, continued surveillance pre-empts human impact.

Essential information is needed to document the conservation status of *Descurainia torulosa* in Region 2. Only one of the six occurrences in Region 2 has been inventoried to determine its precise location, extent, and approximate population size. The highest confirmed population count at this site, based on reproductive plants, totaled six individuals. *Descurainia torulosa* was surveyed in nearby Bridger-Teton National Forest populations (Marriott 1990), and the status information on the occurrences in this close, comparable setting presents a reference for Region 2 for the interim.

Potential Management in Region 2

The information base for directing management is fundamentally incomplete, so that information and research needs are overarching needs. There are three important points to reiterate in the interim. First, even though this species occupies very small areas of habitat, the scale of potential impact needs to be addressed at the scale of the entire cliff face and surrounding slope because any destabilization of surrounding cliff faces and talus slopes potentially impacts the occupied habitat. Second, this species may be vulnerable in the absence of any human activities and developments, so one of the first priorities is to archive seed collections from northern and southern populations as a safety net. This is because it is short-lived, with low population numbers, and occupies a narrow possibly unstable habitat zone. There are life history unknowns that may temper the importance of *ex situ* conservation, including the question whether *Descurainia torulosa* has a seedbank, but it is seen as an appropriate precaution in any case. Denver Botanic Gardens has already been designated as the repository for this species by the Center for Plant Conservation. Third, this assessment is consistent with the status report that was prepared for this species nearby on the Bridger-Teton National Forest (Marriott 1991) and that represents the best information available for the species in Region 2.

Information and Research Needs

There are three pressing information and research needs, and they are presented in a tentative chronology by which early tasks contribute to later tasks. One of the highest priorities is documenting the species' distribution and abundance in Region 2, beginning with systematic inventory and census. There has not been systematic inventory for this species in Region 2 apart from that reported in Dorn (1989), and most of the species' potential habitat is shown to be in Region 2 by models of potential distribution (**Figure 4**). This pertains specifically to the Shoshone National Forest in the southern Absaroka Range. In addition, a survey is needed at each of the six known occurrences on the Shoshone National Forest. Documentation of each occurrence should include detailed documentation of location and extent, accompanied by census, complete lists of associated species, and monitoring or consideration of site suitability and population priority for monitoring. In the ensuing status report, it would be valuable to note signs of stability or instability and to determine whether there are any active natural fault lines near the populations.

Inventory work might be planned using the potential distribution map compared against topographic and geologic maps, together with review of known distribution and consultation with species' experts. Inventory is best conducted when plants are in flower, as they are slightly more conspicuous then, but mature fruit are required for verification. The work requires at least two-person climbing teams, ideally with radios. It is important to tally all flowering plants that can

be accessed, to record whether *Descurainia incana* is present or not, and to estimate, if not tally, all vegetative plants that can be accessed. Access constraints and questions are to be recorded as well.

Population censuses are lacking for half of all known populations, and most of these are in Region 2. Census work needs to be conducted at known sites and incorporated in the inventory work. Techniques have not been described or discussed for the species. Census and monitoring work is impeded by the instability of the habitat and the resulting likelihood that any permanent markers may shift or be lost. In the absence of a single proven technique, it is appropriate to document location by every available technique and to evaluate their effectiveness, including GPS readings, annotated field maps and aerial photos, a labeled series of markers that delimit and extend beyond the population, and photopoints. Vegetative plant census has not routinely been included and might provide a more complete picture regarding if there are habitat trends concurrent with population trends. With the benefit of greenhouse studies (below), it would also be important to conduct census or monitoring for at least two consecutive years.

The second priority is conducting common-garden greenhouse tests to determine whether diagnostic species characteristics and life history traits are genetically fixed or phenetically plastic within and among populations. Such experiments are appropriate only if seed-collecting is not detrimental. This is a relatively simple set of research tasks that would potentially advance taxonomic understanding pending major monographic research and genetics tests. Common-garden experiments would serve to distinguish phenotypic traits of *Descurainia torulosa* from genetic ones within and among populations. Measurements of species' responses to a range of greenhouse conditions that simulate a natural range of growing conditions, e.g., growing season length, moisture level, and diurnal temperature, would be measured in each diagnostic characteristic among northern and southern populations. Any propagating of *D. torulosa* from seed needs careful consideration to the impacts of seed-collecting on the population, and measures should be taken to minimize impacts.

Greenhouse life history research might also contribute to interpreting census results and to developing any more intensive monitoring work. The possibility of distinguishing between vegetative plants of *Descurainia torulosa* and *D. incana* is best researched under greenhouse conditions. Regardless of outcome, it would be far more practical to get background demographic monitoring data in the greenhouse before embarking on monitoring of very small populations in which vegetative identification is uncertain. This greenhouse research would ideally be combined with seed germination research, documenting ideal germination conditions. It might also be carried through to conduct pollination research, evaluating the feasibility of self-fertilization and the accompanying viability. If seed viability is reduced, then genetic research might be pursued to determine the levels of selfing that occur in representative northern and southern populations, and consult entomologists on prospective baseline pollination research.

The third fundamental and more complicated research need is taxonomic research on species concepts and relationships within *Descurainia* to corroborate taxonomic validity of *D. torulosa* at the species or variety levels, and to evaluate the taxonomic relations between northern and southern populations. Genus-level taxonomic research would require morphological analysis drawing from large specimen sets over broad distributions. Accompanying genetic molecular research might investigate select internal transcribed spacer regions of nuclear ribosomal and introns in chloroplast DNA that would probably give phylogenetic signals (Brown personal communication 2002).

Definitions

Appressed – Lying close and flattened to surface.

Cauline – Pertaining to the stem.

Circumboreal – Distributed around the high latitudes of the northern hemisphere.

Clade – A monophyletic group of taxa sharing a closer common ancestry with one another than with members of any other clade.

Cladistic analysis –Analysis of characters or character states from which phylogenetic inferences can be made.

Decumbent – Reclining on the ground but with the tip ascending.

Dormant – Alive but metabolically inactive.

Ecological amplitude – The range of a given environmental factor or plurality of factors over which an organism can function.

Entisol – A major category in the classification of soil types referring to soil lacking a well-defined profile usually because of persistent deposition or erosion.

Herbivory - Feeding of animals on plants.

Holotype – The single specimen designated or indicated as the type specimen of a nominal species by the original author at the time of publication or the single specimen when no type was specified but only one specimen was present.

Introns – In eukaryote chromosomes, that portion of a DNA strand within a gene that does not code for a protein; it is transcribed but subsequently excised from the primary RNA transcript by RNA splicing.

Metapopulation - Subpopulations of natural populations that are partially isolated from one another and are connected by pathways of immigration and emigration.

Mucilaginous – Gelatinous.

Mycorrhizae – The association between a fungus and the root system of a vascular plant.

Pedicels – Stalk of a single flower.

Phenetic – Environmentally-influenced traits.

Phenology – Temporal aspects of recurrent natural phenomena and their relation to weather and climate.

Pinnate –With leaflets, lobes, or veins arising from several different points along an axis.

Polyphyletic – A group or taxon derived from two or more distinct ancestral taxa reflecting evolutionary convergence rather than common ancestry.

Procumbent – Lying or trailing on the ground, but not rooting at the nodes.

Prostrate – Lying flat on the ground.

Rank - NatureServe and the Natural Heritage Program use a ranking system (Internet site: http://www.natureserve.org/explorer/granks.htm). A rank of "G1" indicates that *Descurainia torulosa* is "critically imperiled" rangewide because it is extremely rare and local throughout its range, or because of other factors making it extremely vulnerable to extinction or elimination." A rank of "S1" indicates that it is also critically imperiled in the state (subnation) level. In the case of *Descurainia torulosa*, its entire range lies within the state, so the global and state ranks are automatically identical.

Rosette – Cluster of basal leaves radiating out in all directions from a central point.

Seedbank – The store of dormant seeds buried in soil or in sediments of water bodies.

Semelparous – Pertaining to organisms that have only one brood during their lifetime.

Silique – Elongate fruit in the Brassicaceae usually containing a single, membranous partition with the ovules borne at its points of attachment to the fruit wall.

Stamen – Male organ of flower containing pollen and consisting of filament and anther.

State endemic - Distribution is restricted to a limited geographic region that lies within the state of Wyoming.

Stellate – With three or more branches radiating out from the center.

Sympatric – Related species occurring together in the same geographical area.

Torulose – Alternately swollen and constricted, sometimes irregularly so.

Viability - Capacity for long-term persistence of a species or population under a given set of intrinsic and extrinsic conditions.

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LIST OF ERRATA

09/21/05 Changed peer review organization from Society for Conservation Biology to Center for Plant Conservation on the cover.

03/25/04 Added reference to Fertig and Thurston 2003 (Fertig, W. and R. Thurston 2003. Modeling the Potential Distribution of BLM Sensitive and USFWS Threatened and Endangered Plant Species in Wyoming (http://uwadmnweb.uwyo.edu/WYNDD/Reports/pdf_fertig/FinalReport_03BLMmodeling.pdf). Report prepared for the Bureau of Land Management – Wyoming State Office by WYNDD – University of Wyoming, Laramie, WY). Changes were made in:

- Acknowledgements section
- Figure 6 in List of Tables and Figures
- Page 14 - body of text and Figure 4 itself
- Reference section